Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20544

In the Matter of	)	
	)	
Wireless E911 Location Accuracy Requirements	)	PS Docket No. 07-114
	)	
	)	

COMMENTS OF T-MOBILE USA, INC.

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T-Mobile USA, Inc. ("T-Mobile")[1] hereby submits these comments in response to the Commission's Fourth Further Notice of Proposed Rulemaking ("FNPRM") regarding the adoption of z-axis, or vertical, location information obligations for wireless E911 service.[2]

I. INTRODUCTION AND SUMMARY.

T-Mobile has long been a leader in implementing improvements to wireless E911—most recently by being the first U.S. wireless carrier to incorporate commercial location technologies from both Apple and Google into its E911 services[3]—and supports the Commission's efforts to incent all providers to improve the provision of location information for emergency calls from wireless callers. A 911 call may be the most important call a person makes; therefore, enabling first responders to accurately locate callers is critical.

As the Commission does so, T-Mobile urges it to ensure that any actions it takes regarding vertical location information both account for technological realities and give carriers

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1 T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

2 *Wireless E911 Location Accuracy Requirements*, FCC 19-20, Fourth Further Notice of Proposed Rulemaking (rel. March 18, 2019) ("FNPRM").

3 *See, e.g.*, Ryan Knutson, *Why Uber Can Find You but 911 Can't*, WALL STREET JOURNAL (Jan. 7, 2018) (noting T-Mobile's use of Apple's "Hybridized Emergency Location" service for 911 calls); Steven Mucil, *Google Teams Up with T-Mobile on More-Accurate 911 Location Data*, CNET (Sept. 19, 2018), https://www.cnet.com/news/google-teams-up-with-t-mobile-on-more-accurate-911-location-data/.

and other stakeholders sufficient flexibility to leverage new and evolving commercial location capabilities. First, the Commission should ensure that any metric it adopts for vertical location accuracy accounts for the commercial availability of technologies that are able to meet that metric and, for technologies tested in the Test Bed, that the testing conditions and environments are taken into consideration. With respect to the metric itself, T-Mobile requests that the Commission require carriers to meet the specified accuracy metric for 80 percent of test calls collected in the Test Bed, rather than for 80 percent of all indoor wireless 911 calls. Second, the Commission should recognize that while the commercial marketplace is the best mechanism through which location technologies can be developed, and thus the imposition of technology mandates should generally be avoided, the wireless ecosystem is broad and requires a commitment from all industry stakeholders to work together to provide accurate location information. Finally, the Commission must establish a commonly defined reference system, *i.e.*, WGS-84, for altitude estimates and refrain from requiring carriers to provide the exact floor numbers in buildings or otherwise comply with technically infeasible requirements.

II. A 3-METER METRIC NEEDS TO ACCOUNT FOR CRITICAL DEPLOYMENT FACTORS.

The FCC's proposed 3-meter metric is grounded in the important public safety policy goal of improving the ability of first responders to locate 911 callers.[4] As improvements in location technologies, fueled by commercial developments, have allowed Public Safety Answering Points ("PSAPs") to more accurately pinpoint a 911 caller's horizontal location—that is, x/y geocoordinates—stakeholders have begun investigating how best to locate callers *vertically* as well. Generating and providing vertical location information, however, is much more complicated than providing x/y coordinates, and technologies are still evolving and

[4] FNPRM ¶ 2.

emerging to generate usable z-axis location estimates. This is nowhere more apparent than in the Stage Z testing conducted in the 911 Location Test Bed,[5] in which only two technology providers participated—both of which use barometric pressure sensors to generate vertical location—and the results of which indicate that precise, floor-specific vertical location estimates are still infeasible.

That said, the Stage Z Report indicates that devices that have barometric pressure sensors should be able to generate z-axis estimates that are accurate enough to be helpful for public safety, though neither solution demonstrated the ability to consistently support a +/- 3 meter accuracy metric across all test regions and morphologies. The Commission has nevertheless proposed to adopt a +/- 3 meter metric for vertical location estimates. Any such rules must, however, account for the deficiencies highlighted by the Stage Z Report. Specifically, any new rules based on the performance of barometric pressure sensors and related networks must account for the availability of that technology, both to end users in handsets and in related network deployment.

A. The FCC Must Consider the Availability of Technologies to the Public in Adopting Technology-Based Rules.

Any rules grounded in test data of a particular technology must account for the availability of that technology to the public.[6] Thus, while the nascent vertical location technology solutions tested in the Test Bed have developed to the point of suggesting that high accuracy performance may be achievable in the future, more development work, testing,

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5 *See* 9-1-1 Location Technologies Test Bed, LLC, *Report on Stage Z* (2018), https://www.fcc.gov/ecfs/filing/10803074728956 ("Stage Z Report").

6 *See, e.g.*, T-Mobile USA, Inc. Comments on Third FNPRM on Location Accuracy, PS Docket No. 07-114, at 3-4, 18-20 (filed May 12, 2014) ("T-Mobile Third FNPRM Comments").

refinement, and further improvement is required before a +/- 3 meter vertical accuracy metric can be consistently and reliably met for public safety purposes, particularly in the most challenging urban and dense urban settings where they are most helpful. As a result, any decision by the Commission today to establish a decisive +/- 3 meter accuracy metric will be highly aggressive and present considerable risk, especially within the currently proposed timelines. Nevertheless, T-Mobile intends to continue to help pioneer the further evaluation, development and advancement of vertical location solutions, as it has previously done with horizontal location solutions. Overall, we are confident that these solutions will develop, and will develop best when they occur as part of the evolution of commercial services, as has been the case with x/y geolocation solutions.

Given that the only devices to have been evaluated for vertical location accuracy in the Test Bed to date are those that contain barometric pressure sensors, which are crucial to the vertical location technologies currently being evaluated, any vertical location compliance regime must be specifically targeted to handsets tested in the Test Bed and equipped with barometers and any other functionality necessary to support barometric pressure-based altitude estimation solutions. The Commission has asserted that its proposed 3-meter metric for 80 percent of indoor wireless 911 calls is achievable because "nearly all smartphones on the market appear to be equipped with barometric pressure sensors."[7] But many devices on the market are not smartphones, and some smartphones do not have barometers.[8] Additionally, those devices that

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[7] FNPRM ¶ 26.

[8] For instance, the devices tested in Stage Z by NextNav were four versions of the iPhone (the 7, 7 Plus, 8, and 8 Plus) and two higher-end Android devices from Samsung (the Galaxy S8 and Galaxy 8 Plus). *See* Stage Z Report at 48. Polaris tested on six Android phones: the Essential PH-1, Huawei Mate 9, Motorola Z2 Force, Samsung Galaxy Note 8, Samsung Galaxy S8, and Sony Xperia XZ1 Compact. *Id.* at 52. These are described as "only relatively new handsets" and in fact were all "released more recently than mid-2016," thus,

lack barometric pressure sensors are more likely to be lower priced and used by pre-paid customers and those participating in the Lifeline program. Because there is a substantial installed base of handsets without barometric pressure sensors—including older smartphones—any rule that applies to all wireless calls would have to be phased in over a long enough period of time to account for natural handset turnover, at a time when handset turnover is taking longer.[9] More critically, as the Stage Z Report notes, the solutions tested may not yet be available on consumer handsets;[10] and even handsets with barometric pressure sensors must be capable of being updated with appropriate software to take advantage of data from those sensors for generating location information.

At a minimum, the availability of barometric pressure sensors in handsets will affect the feasible percentage of wireless 911 calls that would be capable of +/- 3 m accuracy by 2021 or 2023. Furthermore, only a minority of indoor wireless 911 calls come from urban/dense urban morphologies[11]—that is, areas with a significant concentration of multi-story buildings where

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the Stage Z Report concludes that "test results . . . cannot be extrapolated to older, less capable handsets." *Id*. at 26. Many lower-end smartphones—such as the Motorola Moto E5 and LG Aristo 2 do not have barometric pressure sensors. *See, e.g.*, PhoneArena.com, https://www.phonearena.com/phones/compare/Samsung-Galaxy-S7,LG-Aristo-2,Motorola-Moto-E5/phones/9817,10782,10875 (comparison between Samsung Galaxy S7, LG Aristo 2, and Motorola Moto E5).

[9] *Cf.* Jake Swearingen, *We're No Longer in Smartphone Plateau. We're in the Smartphone Decline.*, NEW YORK MAGAZINE (Dec. 4, 2018) ("[T]here's no doubt that the replacement cycle for phones is elongating.").

[10] Stage Z Report at 47 ("The NextNav solution currently is not available on consumer handsets, and therefore required a software application, which was installed on the test handsets by FES field technicians and configured for testing using NextNav specifications."); *see also id.* at 51 ("Nevertheless, the Polaris Wireless solution under Stage Z testing currently is not available on consumer handsets and therefore required a software application, which was installed on the test handsets by FES field technicians and configured for testing using Polaris Wireless specifications.").

[11] T-Mobile's live 911 call data collected across the six FCC specified 911 Monitoring Regions, using the ATIS defined morphologies within those regions, indicate that less than 40 percent

vertical location technologies can be presumed to provide critical information for first responders. A proposed mandate that 80 percent of all wireless 911 calls must include vertical location information within the +/- 3 meter accuracy metric may not be in the public interest when as many as 50 percent of handsets in use may not contain barometers[12] and less than 40 percent of 911 calls come from urban/dense urban areas.

A more feasible alternative would be for the Commission to adopt compliance benchmarks that are based on performance measured in the Test Bed. Specifically, T-Mobile recommends a required accuracy metric measured at the 80th percentile of the test calls *collected* in the Test Bed, rather than for 80 percent of all indoor wireless calls to 911, as proposed in the FNPRM.[13]

B. The FCC Must Account for Testing Circumstances in Adopting Technology-Based Rules.

Second, to the extent the FCC relies on the technologies tested in the Stage Z Report, it must account for the testing circumstances of those providers. For instance, as the Stage Z Report notes, the results of vertical location testing cannot necessarily be extrapolated out to all markets, or even to all areas in specified markets.[14] As the Stage Z Report notes, the Test Bed

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of 911 calls originate collectively from Urban and Dense Urban morphologies. The majority of 911 calls originate from Suburban areas, with approximately four percent coming from Dense Urban areas where the highest concentration of multi-story buildings are located.

[12] T-Mobile's data indicate that approximately 50 percent of certified devices on its network today have barometric pressure sensors. This proportion of devices equipped with barometers would be expected to vary across different wireless carriers, as a function of the specific mix of handset types in use (*e.g.*, Android vs iOS, superphones vs affordable phones, post-paid vs pre-paid customers, etc.).

[13] Specifically, T-Mobile recommends that the 3-meter accuracy metric apply at the 80th percentile point on the cumulative distribution function plot of measured error.

[14] *See* Stage Z Report at 4 ("For example, NextNav was unable to participate in every test location (rural areas and Chicago) due to lack of availability of their proprietary technology in those areas."); *id*. at 5 ("[Q]uestions remain about how a barometric pressure-based

data does not support any conclusions about scalability or performance in live calling environments; indeed, the report calls this out by expressly stating that "[t]he results of Stage Z demonstrate that it is challenging to identify a Z-axis metric that can be consistently replicated in a live 9-1-1 calling environment with only two technology vendors participating in this round of Z-axis testing, under somewhat artificial conditions."[15]

Furthermore, the Stage Z Report makes clear that, in addition to handset dependencies to produce accurate vertical location estimates, these technologies are also network/geographic dependent. Vertical location solutions evaluated to date require localized atmospheric pressure reference networks deployed across targeted areas of interest.[16] In the case of NextNav, this takes the form of a terrestrial beacon network; thus, its performance in the Test Bed was undoubtedly biased by its mature deployment in San Francisco, where it has had many years to deploy a network of sensors.[17] In contrast, NextNav did not participate in Chicago where it had no beacon network.[18]

This fact supports the Commission's previous approach of targeting top CMAs at specific points in time for the applicability of vertical location solutions. Requiring high accuracy vertical location information from all geographic areas/morphologies nationwide would not be

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altitude estimation system would perform in a real-world production deployment and how such a system would scale to hundreds of millions of devices across the U.S.").

15 Stage Z Report at 5.

16 *See id.* at 47 ("NextNav's location technology solution relies on its MBS managed network and infrastructure."); *id*. at 59 ("NextNav technology requires an overlay terrestrial beacon network to provide localized atmospheric pressure weather assistance data . . . . Polaris utilized existing sources of localized atmospheric pressure weather data . . . .").

17 *See, e.g.*, Comments of NextNav, LLC, PS Docket No. 07-114 at 2 (filed Oct. 1, 2018) ("NextNav has been developing its MBS technology for nearly a decade and first demonstrated its capabilities six years ago in the San Francisco Bay Area . . . .").

18 *See* Stage Z Report at 4.

necessary or practicable—if it is even feasible. Wireless carriers could instead certify that location solution deployments within the top CMAs are consistent with location solutions measured in the Test Bed, including any required localized reference networks.

III. E911 LOCATION ACCURACY IMPROVES WHEN TECHNOLOGY MANDATES ARE ALIGNED WITH COMMERCIAL LOCATION TECHNOLOGIES.

When carriers have been able to integrate commercial location technologies for E911 purposes, the result has been rapid and significant improvement in accuracy and availability for the provision of x/y location. Of course, the development of successful commercial location technologies has been driven by the consumer market, not by FCC mandates—and until recently, the use of commercial location solutions for 911 purposes was disfavored because it could not be validated.[19] That position has changed as it has become clear that commercial location technologies, such as device-based hybrid technologies, can support emergency location estimates, to the benefit of consumers; today, it is fair to say that use of commercial location technologies has *transformed* horizontal location estimates used for 911. These technologies will continue to evolve and will remain state-of-the-art indefinitely, unlike purpose-built solutions that cannot duplicate the constant and enormous pressure to remain at the forefront of technological evolution felt by commercial providers. In other words, there are commercial incentives to be market leaders in location technologies and these technologies should be harnessed for 911.

It is encouraging, as the FCC notes, that entities outside those tested in the Test Bed, including major mobile OS providers, report they are working to develop and improve vertical

[19] *See, e.g.*, CSRIC III WG3, Leveraging LBS and Emerging Location Technologies for Indoor Wireless E911, at 17 (Mar. 14, 2013), *available at* https://transition.fcc.gov/bureaus/pshs/advisory/csric3/CSRIC_III_WG3_Report_March_%202013_LeveragingLBS.pdf.

location solutions—intended to be leveraged for 911—in the same way they have done for horizontal location.[20] But the current ecosystem for vertical location solutions is much narrower and more limited than were the horizontal solutions available during the timeframe that the Commission was developing the rules outlined in the Commission's *Fourth Report and Order* on location accuracy.[21] Unlike the native, commercially-driven technological development for horizontal location solutions, vertical location solutions today are largely being driven by FCC mandates. One key result of this is that the regulatory requirements for vertical location solutions are well ahead of the underlying technology development process.

In addition, wireless carriers—on whom the Commission would impose location accuracy requirements—are becoming less central to the process of how location information is developed and controlled. As T-Mobile has explained, wireless carriers "cannot by themselves deliver fully 'actionable' horizontal and vertical indoor location estimates."[22] Indeed, other entities, most notably mobile OS providers, now lead the development, implementation, maintenance, and control of underlying location solutions. Google, for instance, has partnered with emergency technology companies like RapidSOS and West so that they can provide location information to 911 operators through the Android operating system.[23] And Apple has

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[20] FNPRM ¶ 18 & n.53 (noting that Google has stated that it is "working to provide accurate altitude and floor location and 'improve [Emergency Location Service] location quality, especially for challenging locations, such as urban canyons and indoors'").

[21] *Wireless E911 Location Accuracy Requirements*, Fourth Report and Order, 30 FCC Rcd 1259 (2015).

[22] T-Mobile Third FNPRM Comments at 1.

[23] *See* Monica Alleven, *Google Launches Emergency Location Service in U.S. with T-Mobile* (Sept. 19, 2018), https://www.fiercewireless.com/wireless/google-launches-emergency-location-service-u-s-t-mobile (reporting that "[m]ost T-Mobile customers with Android devices will now send location data from Google's [Emergency Location Service], but in markets where RapidSOS is integrated into emergency call centers, Android users will send the information through the startup company").

likewise announced that its operating system will use an emergency technology company to enable 911 call centers to immediately identify locations of Apple phone users.[24]

Given this paradigm-shift, it is essential that, as T-Mobile and others have observed, these entities begin to commit to a path to obtain higher location accuracy within the contemplated timelines and to make this location information available for 911.[25] This commitment could start with an agreement to enter the Indoor Z-Axis Test Bed this year for formal performance evaluation as well as commitments to meet the timelines under consideration. While T-Mobile does not support the regulatory imposition of technological mandates generally, it is important that, as the wireless ecosystem continues to expand, *all* relevant stakeholders commit to providing accurate location information. As the Commission has recognized, when public safety is involved, everyone must be involved.[26] Mobile OS

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[24] *See* Press Release, Apple, *Apple's iOS 12 Securely and Automatically Shares Emergency Location with 911* (June 18, 2018), https://www.apple.com/newsroom/2018/06/apple-ios-12-securely-and-automatically-shares-emergency-location-with-911/.

[25] *See, e.g.*, T-Mobile USA, Inc. Reply Comments on Third FNPRM on Location Accuracy, PS Docket No. 07-114, at (filed July 14, 2014) (explaining that "support from all stakeholders, including carriers, public safety, state and local governments, premise owners, handset manufacturers, operating system developers, and others" is required for accurate and reliable location data); Comments of AT&T, PS Docket No. 07-114, at 4 (filed May 12, 2014) ("Public safety is everybody's job."); Comments of Cisco Systems, Inc., PS Docket No. 07-114, at 4 (filed Dec. 10, 2014).

[26] *See, e.g.*, *Wireless Emergency Alerts; Amendments to Part 11 of the Commission's Rules Regarding the Emergency Alert System*, Second Report and Order and Second Order on Reconsideration, 33 FCC Rcd 1320, ¶¶ 17-21 (2018) (requiring industry to work together, in a flexible manner that fits within existing Wireless Emergency Alert ("WEA") interface designs, to preserve Alert Messages on WEA-capable mobile devices because they may contain potentially life-saving information); *see also Implementing Public Safety Broadband Provisions of the Middle Class Tax Relief and Job Creation Act of 2012 et al.*, Second Report and Order, 28 FCC Rcd 15174, ¶ 2 (2013) (adopting technical rules for spectrum licensed to the First Responder Network Authority "in light of the urgent need to resume our process for certifying equipment for use in promoting more effective public safety operations in this band").

providers have particularly touted their abilities to meet or exceed the Commission's location requirements and therefore should be committed to doing the same for vertical location requirements.[27]

Moreover, while T-Mobile supports the adoption of vertical location rules, it is concerned that a mandate based on the performance of a single technology (barometric pressure sensors) in only three markets—one of which is a market in which one technology provider has had more than a decade to build a robust network—may not provide sufficient flexibility to carriers. As of today, the only tested technologies are those offered by NextNav and Polaris. If in the intervening years, new technologies develop that are demonstrably capable of meeting the 3-meter vertical metric in real-world deployments, carriers can be expected to migrate to those new technologies. Therefore, the Commission must ensure that its rules give carriers the flexibility to leverage these developing technologies as they come to market and that emergency location technologies will remain aligned with commercial location services.

IV. THE FCC MUST PUT APPROPRIATE BOUNDARIES ON ITS OTHER PROPOSED MANDATES.

Today's location solutions estimate altitude above a reference surface. The most common reference surface, by far, is WGS-84—the reference system utilized for GPS locations worldwide.[28] T-Mobile and other wireless location providers currently utilize this reference system when providing x/y location estimates. T-Mobile strongly recommends that the

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[27] *See* Press Release, Apple, *Apple's iOS 12 Securely and Automatically Shares Emergency Location with 911* (June 18, 2018), https://www.apple.com/newsroom/2018/06/apple-ios-12-securely-and-automatically-shares-emergency-location-with-911/ ("The FCC requires carriers to locate callers to within 50 meters at least 80 percent of the time by 2021. iOS location services are capable of exceeding this requirement today, even in challenging, dense, urban environments.").

[28] World Geodetic System 1984, http://www.unoosa.org/pdf/icg/2012/template/WGS_84.pdf.

Commission adopt WGS-84 as the reference system for altitude estimates. Having a commonly defined reference system for altitude estimates is essential to allow PSAPs to prepare for receiving and efficiently utilizing altitude information in association with 911 calls. T-Mobile further recommends that no intermediate altitude conversions take place between the wireless carrier and the end-user (*e.g.*, the PSAP), as any added conversion steps will contribute additional error to the underlying location estimate. The PSAP, as the end-user of the information, should be in the position to directly use the altitude estimate as received, as they do today for x/y location, or to convert it to another reference system at their discretion.

T-Mobile strongly opposes any requirement that carriers somehow convert altitude information into a specific building floor identifier. Any such requirement would be technically infeasible, and there is no reason to believe that reverse geocoding by carriers operating nationwide or across a broad region would be more reliable than reverse geocoding by PSAPs familiar with local conditions. No such conversion databases are currently available to wireless carriers and are unlikely to even exist for the vast majority of multi-story buildings. T-Mobile has no reason to believe this information will be widely available any time soon. If, in time, such detailed in-building map data were to become available, the individual PSAP would likely be best suited to conduct such a conversion—given the fact that their CPE equipment already carries out location information conversions, such as converting an x/y location estimate to a dot on a map, or in some instances into a civic address, and their familiarity with local building infrastructures. PSAPs and public safety are best equipped to determine how to effectively utilize location information provided for their individual purposes.

V. CONCLUSION.

T-Mobile is proud to be a leader in wireless E911, and it supports the Commission in adopting new rules that will benefit consumers when they make that all-important 911 call. But

an admirable goal cannot make a technically infeasible mandate achievable, and the Commission should not adopt new, unachievable obligations and plan to address stakeholders' inability to comply by granting waivers. T-Mobile supports the adoption of a vertical location metric with feasible and achievable benchmarks. But aspirational rules that do not account for technological realities will leave carriers with no means of complying—likely leading to a raft of waiver requests.

The Commission should therefore ensure that its vertical location accuracy rules account for the deployment of vertical location technology by requiring carriers to meet the specified accuracy metric for 80 percent of test calls collected in the Test Bed rather than for 80 percent of all indoor wireless 911 calls. The Commission should also avoid adopting mandates that would limit carriers' flexibility in incorporating developing commercially-available location technologies for use with wireless E911.

Respectfully submitted,

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